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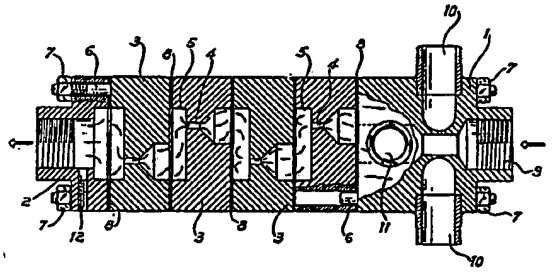
(54) Static type flow emulsifier for non mixable liquids.

(57) A flow emulsifying device for fuel-water mixtures and the use thereof to supply oil fuels emulsified with water to boiler burners are described. The device works based on suction, taking advantage of abrupt variations of velocity and pressure caused in a continuous stream of fuel and water in suitable ratios. The velocity and pressure variations are obtained through a series of narrow passages (4) and expansion compartments (5).



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"STATIC TYPE FLOW EMULSIFIER FOR NON MIXABLE LIQUIDS"

This invention relates to a device for emulsifying water and liquids non mixable therewith. More particularly, the invention is concerned with a fluidic type static emulsifier to provide stable and finely dispersed emulsions of the water-in-oil type for boiler burners feeding.

It is known that most chemical reactions are favoured by the presence of water, to the extent that it would be impossible for many of them to take place in a completely anhydrous environment. Water in fact, due to the dissociation into the basic ions thereof, becomes an active catalyst for both the ionic as well as the radical reactions. Based on these concepts too, in addition to thermodynamic and cost considerations, there has already been known for some time the possibility of using, for instance for boiler burners feeding, an emulsion as homogeneous as possible of a hydrocarbon fuel with a certain amount of water, instead of the same straight fuel as it is commercially available. Use of such combustible emulsions has proved in fact particularly satisfactory for a better quality of the resulting flame, for a more complete combustion of the fuel itself, which leads to a quantitative reduction and qualitative improvement of the unburnt matter, etc. These hydrocarbon and water emulsions, of the water-in-oil type, are currently obtained just before intake to the burner, through the use of emulsifier devices based upon several

different concepts: thus some apparatuses are known where emulsifying is obtained by leading the liquids to be emulsified into contact with vibrating blades; apparatuses where emulsifying is obtained through the use of ultrasonics; and also forced flow emulsifier apparatuses where a coarse dispersion obtained for instance by a turbulence action is subjected to a high pressure compression through a narrow cavity provided between a conic member and its own seat, and afterwards is rapidly expanded and violently projected against an obstacle causing a fine splitting of the particles involved. An emulsifier apparatus that is based on the principle of forced outflow is comprised of an expansion compartment located immediately downstream of an orifice or narrow passage in order to subject the liquid flow to abrupt variations of pressure and velocity. An upstream located compressor provides the pressure supply necessary for the flow of the liquid or liquids, in order to overcome the resistance opposed by the orifice, therefore violently projecting the flow of liquid inside the idle mass of the expansion compartment as well as against the opposite wall of said compartment, in order to take advantage of the resulting swirling motion.

Although all of the devices mentioned above can provide quite fine emulsions, they are affected by a common drawback, since they have to be an integral part of the burner, which creates serious difficulties when they have to be installed on existing burners.

In some cases, the unsatisfactory quality of the resulting emulsions makes it necessary to resort

to special low temperature heat exchangers as a replacement for existing ones; this being necessary in order to provide a remedy against dissociation of the two fluids due to vaporization of one of them.

Therefore, the object of this invention is to provide a stable, finely dispersed emulsion, of the water-in-oil type, particularly suitable for use as a boiler burners fuel. According to this invention, said stable emulsion is obtained using a flow emulsifier working under reduced pressure.

The emulsifier according to this invention substantially comprises a set of two or more expansion compartments, connected in series to each other through reduced area orifices acting as narrow passages. A suction pump is provided downstream of the device, whereby the non mixable fluids to be emulsified are drawn from respective tanks in such a way as to make the combined flow of the two liquids to go through the sequence of compartments in series, so that it undergoes a number of subsequent compressions and expansions, as well as shocks against the compartment walls. Downstream of the pump the emulsion thus obtained is subjected to the pushing action of the pump so that it is forwarded under pressure directly to the burner.

The construction details, the features and advantages of the emulsifier device according to this invention will now be described more particularly, based on the following description made with reference to an embodiment thereof shown only of illustrative purposes and with no meaning of limitation in the

attached drawings, in which:

FIGURE 1 is a partial sectional view of a preferred embodiment of the device according to this invention, including four subsequent expansion compartments, with respective narrow passages;

FIGURE 2 illustrates schematically the device of Fig. 1 installed in an operating position in a piping assembly for supplying a burner; and

FIGURE 3 illustrates schematically the diagrams showing the velocity and pressure variations for a fluid flowing under suction through the various parts of the device according to Fig. 1.

Referring now to Fig. 1, where a preferred embodiment of the device according to this invention is illustrated, there is shown that the device is comprised of an intake flange 1, an outlet flange 2, and identical elements 3 provided in between, each comprising an orifice 4 and an expansion compartment 5. Elements 3 are located such that the orifices 4 are alternatively axially offset in order to make the fluid flowing subsequently through them (right to left, in the drawing) to undergo a number of abrupt deflections. The assembly is securely fastened together by a number of tie-rods 6 clamped at the ends thereof by nuts 7, while the sealing effect between adjacent elements is secured by means of suitable gaskets 8.

The intake flange 1 is provided with an axially disposed inlet fitting 9 for the liquid having higher viscosity (fuel), one or more radial inlet fitting 10 for the less viscous liquid (water), and one or more fittings 11 also radially disposed

whose function will be better explained in the following, openings 12 being in addition provided both on the intake as well as on the outlet flange for the installation of monitoring pressure gauges.

As it is best seen in Fig. 2, a piping 13 is connected to inlet fitting 9 for supplying the fuel which is withdrawn from a tank 15 by means of a pump 14, while on the outlet fitting 2 a piping 16 is connected whereon a pump 17 is provided to propel the fluid towards a burner 18.

The fuel withdrawn form tank 15 by means of pump 14 is conveyed, under low pressure ranging from 147 to 294 kPa, along conduit 13 to the intake flange 9 of the emulsifier according to this invention, whereat it meets with water coming through Venturi effect from piping 19 connected to one or more intake fittings 10. Pump 17 provided downstrean of the emulsifier along piping 16 and working at a pushing pressure ranging from 1961 to 2942 kPa, subjects the liquid flow coming from the emulsifier to a strong suction, drawing the heterogeneous mixture of fuel and water coming from flange 1, which is forced to go through the sequence of offset orifices 4. This sequence of forced transitions under reduced pressure subjects the flow of abrupt velocity changes with corresponding compression effects at the orifices 4. Said forced transitions through orifices 4 provide the liquid with a high velocity, and accompanying violent projection against the opposite wall of compartments 5, where the liquid stream refracts and expands. The combined action of the repeated shocks

undergone by the forming emulsion combined with the effect of reduced pressure, subjects the water droplets to a number of subsequent expansions, so that they vaporize suddenly with an ensuing dispersion and intimate atomization effect in the stream of fuel oil. The following compressions cause a new condensation, and therefore the formation of a higly homogeneous emulsion. This is due to the fact that the total pressure (dynamic plus static pressure) in critical points of the emulsifier is lower than ambient, which gives rise to the dispersed water vaporization. The excess of fuel-water emulsion possibly resulting from a incomplete combustion through the burner 18 is recirculated through piping 20 and fittings 11 towards intake flange 1, where it mixes with fresh incoming fuel. Similarly, the possible excess fuel drawn by pump 14 is returned to tank 15 by means of piping 21.

The velocity and pressure variations taking place inside a four expansion compartments emulsifier according to this invention are shown in Fig. 3.

The emulsifier device according to this invention, which can include a number of expansion compartments ranging from two to four or more, depending on operation requirements and properties of the non water-mixable liquid to be emulsified, provides highly homogeneous and stable emulsions, even though they are not immediately put in use, and containing from less than 10% to more than 37% by wt of water, with emulsion flow rates ranging from 0 to about 4000 kg/hr. While the temperature of the liquid feed does not represent a limiting factor, at least at ambient

temperatures, it is preferable that the temperature of the liquids to be emulsified ranges between 40°C and 110°C. Therefore, the emulsifier device according to this invention provides a stable emulsion between two non mixable fluids and/or having different viscosity. The most interesting application of the aforesaid emulsifier is the preparation of highly fine and homogeneous emulsions for supplying boiler burners of any capacity and type with liquid fuels, for the purpose of obtaining a perfect combustion, a high performace and a strong reduction of unburnt matter in the exhaust gases to the environment.

The subject device, compared to the ones presently available on the market, provides a high quality of the emulsion obtained, ease of installation and operation, being simply inserted in series of the fuel piping to the burner, ahead of the pump, thereby making special arrangements unnecessary; it can also be used with any of the existing types of burners; it does not require any maintenance while providing for a high operational safety, the relevant production costs being kept particularly low since the device is a modular core type. The modularity of the expansion compartments comprising the central body of the device allows to modify the operational features thereof, according to requirements, by a simple addition or withdrawal of elements.

The installation of the device according to this invention, ahead of the burners, does not require modifications to the burners themselves, and the produced emulsion can be heated by means of a usual

electric pre-heater without causing evaporative water losses, therefore making unnecessary the replacement of existing pre-heaters on the burners.

As already described, the device works under reduced pressure, through the suction effect of the burner pump, so that high operating pressures are not required. While this invention has been described with reference to a particular embodiment thereof, for use in connection with boiler burners; it can be applied to provide emulsions of any kind and for any use, where a liquid having a sufficiently high vapour pressure must be emulsified with another non-mixable liquid, having a lower vapour pressure. Accordingly, the device of this invention can be used, for example, to provide emulsions of water or acqueous liquids, e.g. solutions, suspensions etc., with non-mixable liquids, in particular oily liquids, having a lower vapour pressure.

While modifications and/or variations can possibly be made to the device according to this invention by those skilled in this art, they will have to be considered as falling within the scope of protection of the subject invention.

CLAIMS

1. A fluidic type static emulsifier through which a mixture of two or more non-mixable liquids having different viscosities is forced to flow, characterized in that it substantially includes at least two narrow passages or orifices (4) provided in sequence and alternating with respective expansion compartments (5) through which said mixture is made to flow.

2. The emulsifier according to claim 1, characterized in that said orifices (4) and the related expansion compartments (5) are mutually and alternately offset.

3. A fluidic type emulsifier according to claim 2, characterized in that the forced flowing-through of said liquids is caused by the suction effect of a pump (17) located downstream of said emulsifier.

4. The emulsifier accordinc to claim 1, characterized in that the liquid having higher viscosity is subjected to suction in an axial direction (13), the liquid or liquids having lower viscosities being radially sucked (10) into the stream of said liquid having higher viscosity.

5. The emulsifier according to claim 2, characterized in that each of said orifices (4) and the respective expansion compartment (5) is a part of a separate modular element (3), said modular elements being mounted mutually adjacent with the orifices successively offset, the single elements (3) being separated by sealing gaskets (8).

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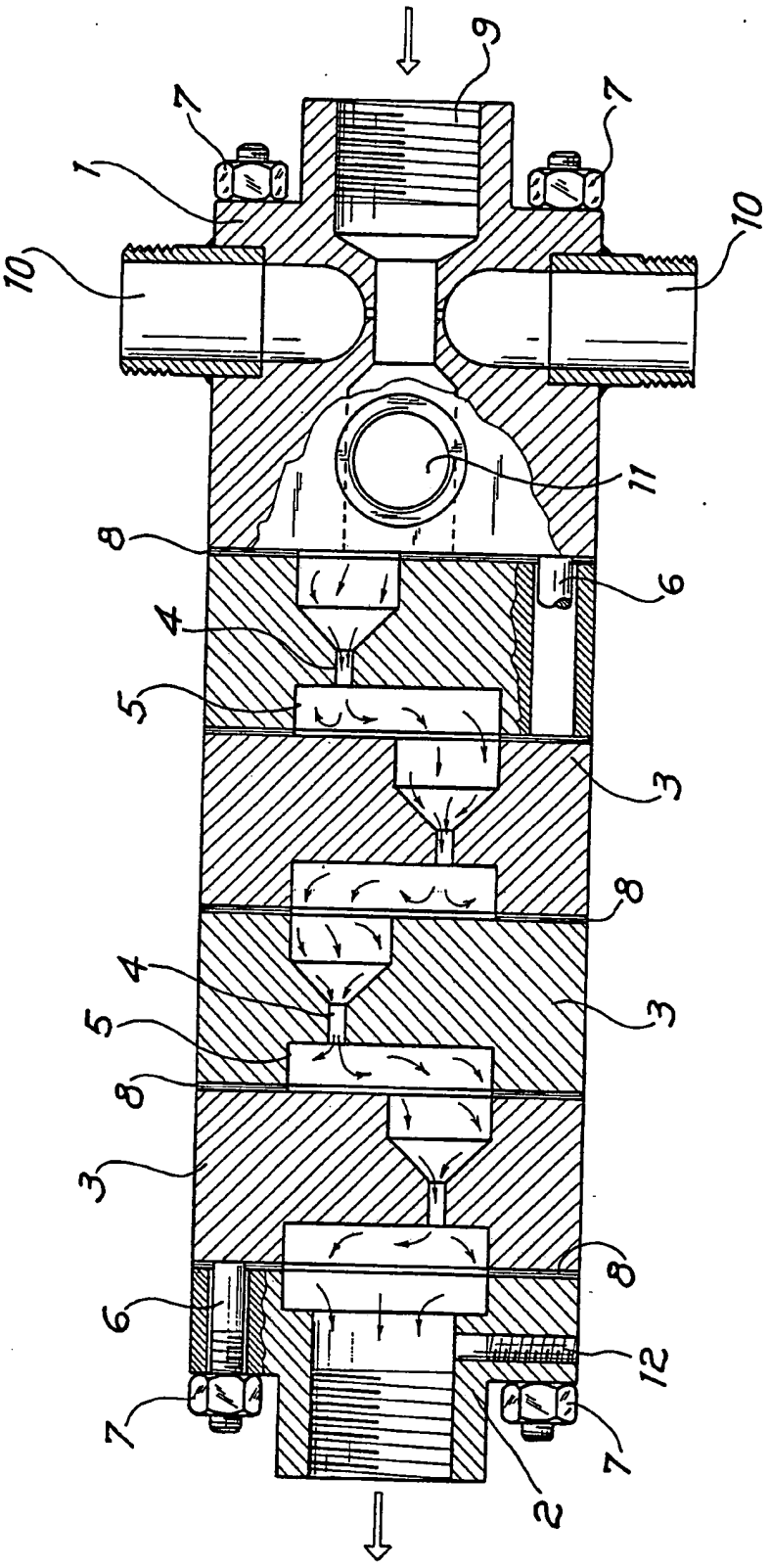

Fig. 1

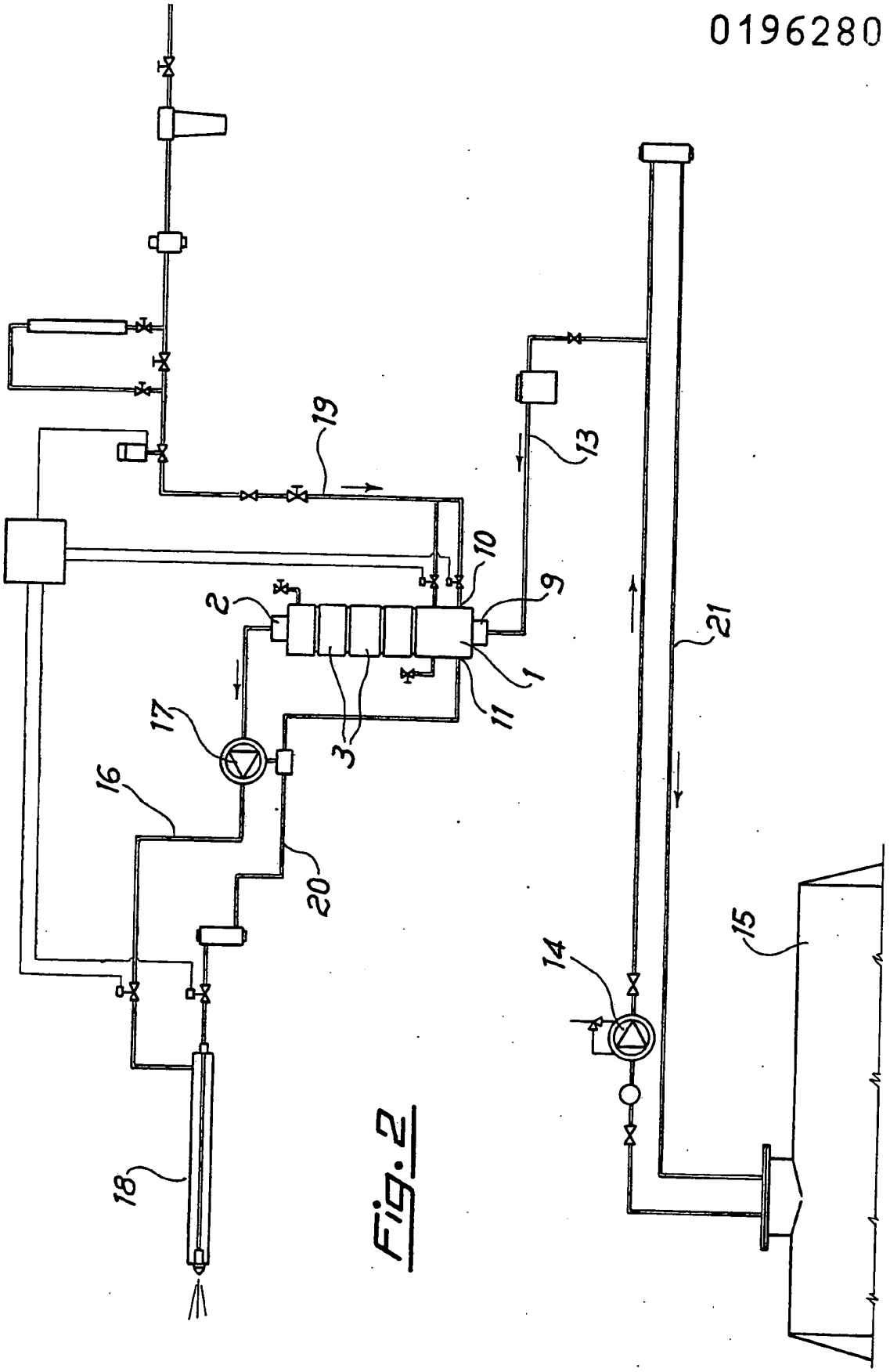

Fig. 2

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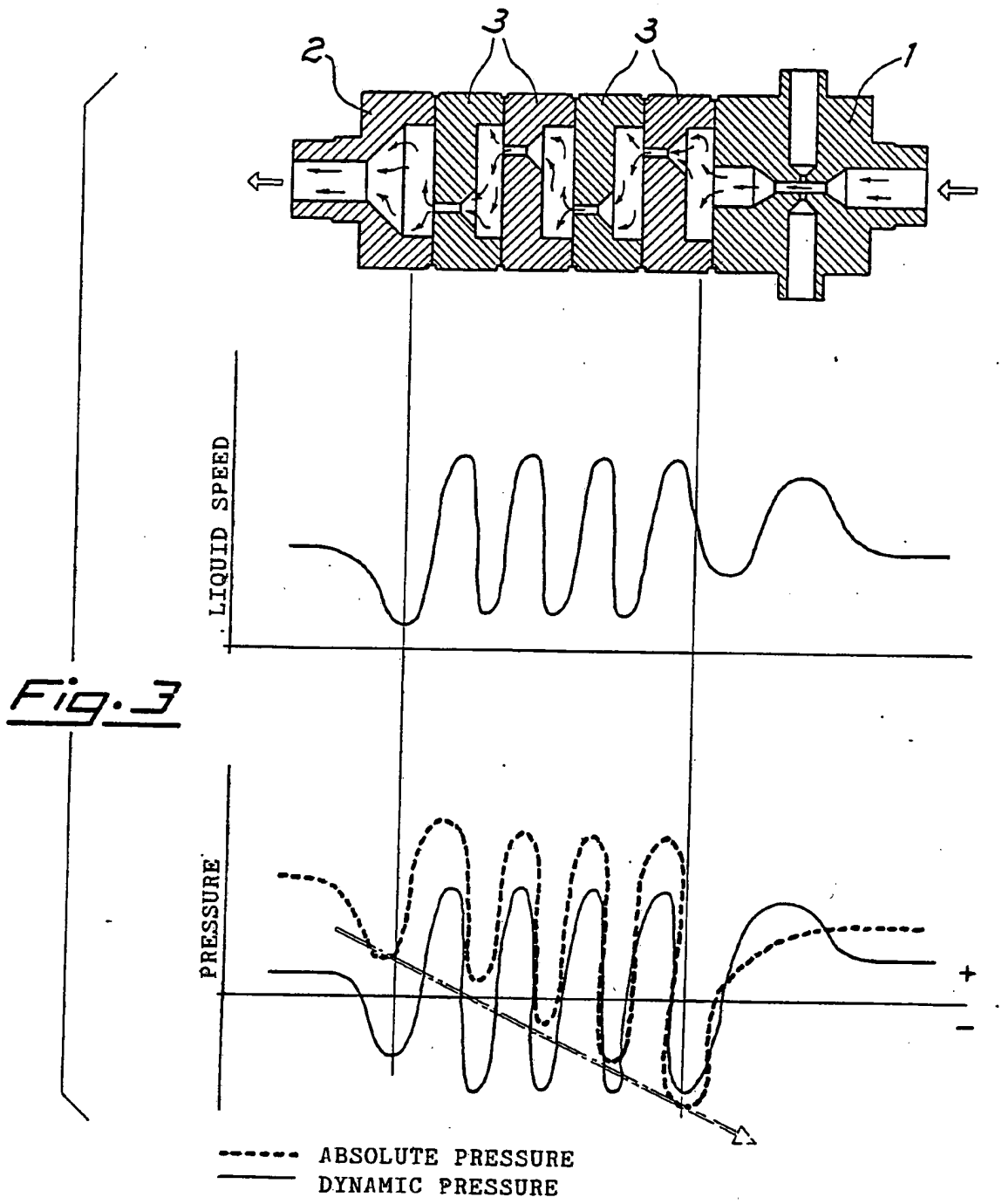

Fig.3